

Specification

Sliding Bearing

Technical Field

5 The present invention relates to a sliding bearing, more particularly to a sliding bearing for an internal combustion engine, which consists of an aluminum-alloy bearing layer pressure-bonded on the backing metal, and an overlay covering the aluminum-alloy bearing layer and consisting of a solid lubricant such as MoS_2 and a binder resin.

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Background Technique

 The present applicant has published the sliding bearing having the above-described type in Tribology Prepublished Lectures Tokyo, 1999-5 (May 10 through 12, 1999), A12. The aluminum bearing alloy used is Al-12.5Sn-2.7Si-1Cu-0.2Cr-2Pb. The
15 solid lubricant used is MoS_2 , graphite or h-BN. The binder used is epoxy resin and polyamide imide (PAI) and the like.

 A preferable composition to improve the seizure resistance and the fatigue resistance of the MoS_2 -PAI based overlay is from 30 to 95 mass % of MoS_2 , the balance being PAI resin.

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 In the conventional overlay, an increase in the MoS_2 amount, which improves the initial conformability, is advisable to improve the seizure resistance. This method leads to reduction in the hardness of the overlay and hence to impair the wear resistance. The MoS_2 -PAI-based overlay with much MoS_2 is likely to wear out, so that the underlying aluminum-alloy is exposed. As a result, bearing failure such as fatigue
25 occurs. Contrary to this, an increase in the resin amount and hence an increase in the hardness is effective for improving the wear resistance. This incurs, however, an increase in the friction coefficient and hence an increase in the initial conformability. As is described hereinabove, the MoS_2 -PAI based overlay with much MoS_2 can prevent the exposure of the underlying aluminum-alloy, but the seizure of the overlay and a shaft is
30 liable to occur. It turned out that such contradictory phenomenon is prominent in a high-revolution type engine.

Disclosure of Invention

 The conventional overlay has been designed in such a manner that a single
35 layer attains good performance. The present inventors recognized that : only the top part of the overlay is required to exhibit initial conformability in a high-revolution type

The upper layer of the overlay contains a solid lubricant consisting of MoS_2 , which exhibits excellent initial conformability. Its content is preferably from 40 to 95 mass %, more preferably from 50 to 80 mass %. A small amount of a solid lubricant other than MoS_2 may be used in combination.

5 The lower layer contains one or both of the solid lubricants or the hard additives (additives). The amount of the additives is preferably from 30 to 85 mass %, more preferably from 30 to 60 mass %. When the solid lubricant consists only of MoS_2 or is a combination of MoS_2 and other component(s), the content of MoS_2 in the lower layer should be relatively lower than that in the upper layer. The MoS_2 content of the upper
10 layer is higher than that of the lower layer by preferably 10% or more, more preferably by 15 to 20%.

The solid lubricant of the lower layer may be graphite, zinc sulfide, tungsten disulfide and/or hexagonal boron nitride which replaces MoS_2 or is added in addition to MoS_2 .

15 The hard additive is specifically at least one selected from the group consisting of Si_3N_4 , SiO_2 , SiC and Al_2O_3 . The content is preferably from 0.1 to 10 mass %, more preferably from 1 to 5 mass %.

In the present invention, the components and composition of the upper and lower layers are constant in the respective layer. If necessary, the upper layer may be
20 embodied as two or more sub-layers having different MoS_2 content. The MoS_2 content of the upper sub-layer is greater than that of the lower sub-layer, thereby forming a concentration gradient. In this embodiment, the initial conformability of the upper layer is attained at a furthermore higher level. Likewise, the lower layer may be embodied as two or more sub-layers having different content of the additive. The additive content of
25 the upper sub-layer is greater than that of the lower sub-layer, thereby forming a concentration gradient. In this embodiment, the wear resistance of the lower layer can be realized for an extended sliding distance. The upper layer having the concentration gradient as described above has a higher average MoS_2 content than the average MoS_2 content of the lower layer. More preferably, the gradient of MoS_2 concentration is
30 established in the entire overlay. The particle diameter of the additive is not particularly limited, but the average diameter is preferably in the range of from 0.1 to 2 μm .

The binder resin preferably used is polyamide imide.

35 The overlay according to the present invention may be an inclined layer structure consisting of an upper layer, an intermediate layer and a lower layer. The intermediate layer has the identical component as that of either of the upper layer

having a single composition or the lower layer having a single composition. In addition, the composition of the upper and lower layers may not be distinctly differentiated. That is, not stepwise but gradual decrease of MoS₂ and increase of hard additive from the upper and lower layers may be carried out. No adherence problem between the upper and lower layer occurs, so that stable initial conformability and wear resistance can be attained.

The overlay is preferably from 2 to 15 μ m thick, more preferably from 3 to 9 μ m thick. The upper layer is preferably from 1 to 5 μ m thick, more preferably from 2 to 4 μ m thick.

The upper and lower layers according to the present invention can be prepared by means of applying on the cleaned surface of aluminum-alloy the resin, which contains a predetermined additive, and subsequently curing at 180 to 270°C. That is, neither special surface treatment nor polishing is carried out after the curing.

The present invention is hereinafter described with reference to Examples and Comparative Examples.

Best Mode for Carrying Out the Invention.

The upper layer (2 μ m of thickness), the intermediate layer (1 μ m of thickness), and the lower layer (4 μ m of thickness) having the compositions shown in Table 1 were formed on the aluminum-bearing alloy (composition – Al-Sn based). The aluminum alloy was pressure-bonded on a low-carbon steel sheet by a conventional method. The balance of the additive is polyamide imide. The sliding bearings produced as described above were subjected to the seizure-resistant test and wear-resistant test described below.

Seizure Resistant Test

Tester: high surface-pressure bearing tester

Opposed shaft: S55C (quenching hardened)

Lubrication: oil-supply to a shaft

Method for imparting load: successive increase

Wear Resistant Test

Tester: rotary load tester

Opposed shaft: S55C (quenching hardened)

Lubrication: oil-supply into a shaft

Load: static load

The results of the test are shown in Table 1.

Table 1

Upper Layer MoS ₂	Intermediate Layer		Lower Layer		Results		Remarks
	MoS ₂	Hard Matter	MoS ₂	Hard Additive	Seizure Surface Pressure	Wear Amount	
55%	55%	1%Si ₃ N ₄	40%	1% Si ₃ N ₄	75MPa	1 μm	Example 1
↑	↑	3% Si ₃ N ₄	↑	3% Si ₃ N ₄	75MPa	1 μm	Example 2
70%	70%	1% Si ₃ N ₄	40%	1% Si ₃ N ₄	80MPa	3 μm	Example 3
↑	↑	↑	30%	↑	80MPa	2 μm	Example 4
↑	↑	1%BN	↑	1%BN	80MPa	2 μm	Example 5
↑	↑	1%ZnS	↑	1%ZnS	80MPa	2 μm	Example 6
40%MoS ₂					60MPa	1 μm	Comparative Material(Single Layer)
70%MoS ₂					55MPa	5 μm	Comparative Material(Single Layer)

Industrial Applicability

As is described hereinabove, the overlay consists of an upper layer and a lower layer. Importance is attached to the upper layer with regard to the conformability. Importance is attached to the lower layer with regard to the wear resistance. As a result, the seizure resistance can be increased, while the wear resistance can be kept to a low level.